# SECTION III: TAPS Leak Detection

## 1. Agency Jurisdiction:

Alaska Administrative Code, Title 18, Chapter 75, as administered by ADEC states: "(a) A crude oil transmission pipeline must be equipped with a leak detection system capable of promptly detecting a leak, including (1) if technically feasible, the continuous capability to detect a daily discharge equal to not more than one percent of daily throughput; (2) flow verification through an accounting method, at least once every 24 hours; and …." [18 AAC 75.055(a)]

BLM administers the Federal Agreement and Grant of Right of Way for TAPS, which requires APSC to annually submit a Cplan for review and approval. As used in Stipulation (2.14.2), Oil Spill control includes the detection of a spill and thus leak detection.

## 2. Background:

APSC has three different leak detection systems in place: 1) Deviation Alarms, 2) Line Volume Balance (LVB) and 3) Transient Volume Balance (TVB). The size of the leak on October 4, 2001 was too small to trigger the Deviation Alarms. The time interval between visual detection and pipeline shutdown was less than the time interval required for LVB to detect and trigger an alarm. The pipeline shutdown was begun within 30 minutes of the onset of the leak. Only the TVB had a theoretical chance of detecting and alarming for a leak of this magnitude in the 30-minute time window between the onset of the leak and pipeline shutdown.

In order to deal with instrument noise, data degradation, and other dynamic operating activities that generate hydraulic transients, the TVB reduces its effective alarm sensitivity for a period of time following such disruptions. This process is called data validation (note: this process is actually a form of statistical analysis to determine the effective alarm sensitivity). Post event analyses shows that the leak was sensed by TVB at 2:44 PM, approximately 13 minutes after the onset of the leak; however, the data validation requirements rejected the event. Figure III-1 clearly shows the initiation of the leak at 2:31 PM. However, it also shows even larger excursions associated with the passage of the cleaning pig through Pump Station 6. The leak would have had to be approximately 350 barrels per hour (BPH) leak rate, to meet the validation conditions existing at 2:44 PM. If the leak had occurred just prior to the pig passage an alarm would have sounded at the pipeline console. Without the leak validation process, the TVB segment between Pump Stations 6 and 7 would have been in an alarm state for much of the time period between October 2, 2001 and October 4, 2001. This time period is associated with the pig passage through this segment and would have been attributed to the flow measurement shift generated by the pigging operation.

Although the TVB did not alarm, it is estimated that LVB would have alarmed within 4 to 10 hours after the start of the leak. The LVB leak detection sensitivity had been reduced earlier in the day by the idling of the North end of the pipeline at 9:58 AM. Prior to this event, the LVB sensitivities were well below the initial 5500 barrels per day (BPD) leak rate caused by the bullet hole.

Continuous and accurate flow measurements are essential for the operation of flow-based leak detection systems such as LVB and TVB. Non-quantifiable flow measurement shifts as observed prior to the October 4, 2001 event temporarily reduce the sensitivity of leak detection systems until steady-state conditions are reestablished. Specific operations such as pipeline shutdowns, restarts, pump switch overs, and pigging operations can create these temporary flow measurement shifts. As an example, lower oil temperatures and resultant increased waxing has necessitated more frequent cleaning pig runs on TAPS. The increase in the number of these operations in turn, increases the likelihood for a temporary reduction in leak detection sensitivity as the pig passes through the station facilities. APSC has recognized these detection sensitivity impacts and the need to continue with improvements to its Leak Detection capability. Prior to the October 4, 2001 event, APSC began a two-year $2.5M Pipeline Leak Detection Improvement Project to further enhance the leak detection capabilities on TAPS.

**Definitions:**

**Deviation Alarms:** The deviation alarm system detects large leaks, greater than 1% of pipeline oil flow. There are three types of deviation alarms: 1) Pressure alarms are activated when the oil pressure changes by more than 15 psi; 2) flow alarms are activated if the amount of oil entering or leaving a station varies too much between check times; and 3) flow deviation alarms are activated when the difference in the amount of oil flow between the upstream and downstream pump stations changes greater than 700 BPH.

**Line Volume Balance (LVB):** LVB is a line-wide leak detection system that depends on the statistical analysis of pipeline flow measurements. This system requires a minimum of two hours to determine a leak. It does not model physical pipeline oil flow. It does not have good leak location ability and does not handle unsteady flow conditions. The system statistically determines imbalances for the analysis for 48 hours of data with measurements taken every 30 minutes.

**Transient Volume Balance (TVB):** TVB is APSC's most rapid method of detecting small leaks. It analyzes pipeline segments between pump stations every 60 seconds. It models unsteady flow conditions and calculates for imbalances for five time periods ranging from four minutes to the recent eight hours.

**Leading Edge Flow Meters (LEFMs):** The LEFMs are located at the discharge of Pump Station 1 and the suction and discharge for all other Pump Stations. The LEFM estimates oil flow volume from the time it takes sound to travel in the direction of oil flow versus against the direction of flow. The result of these measurements is a velocity profile for the oil. Given the pipe cross sectional area and oil properties, the oil flow rate is determined.

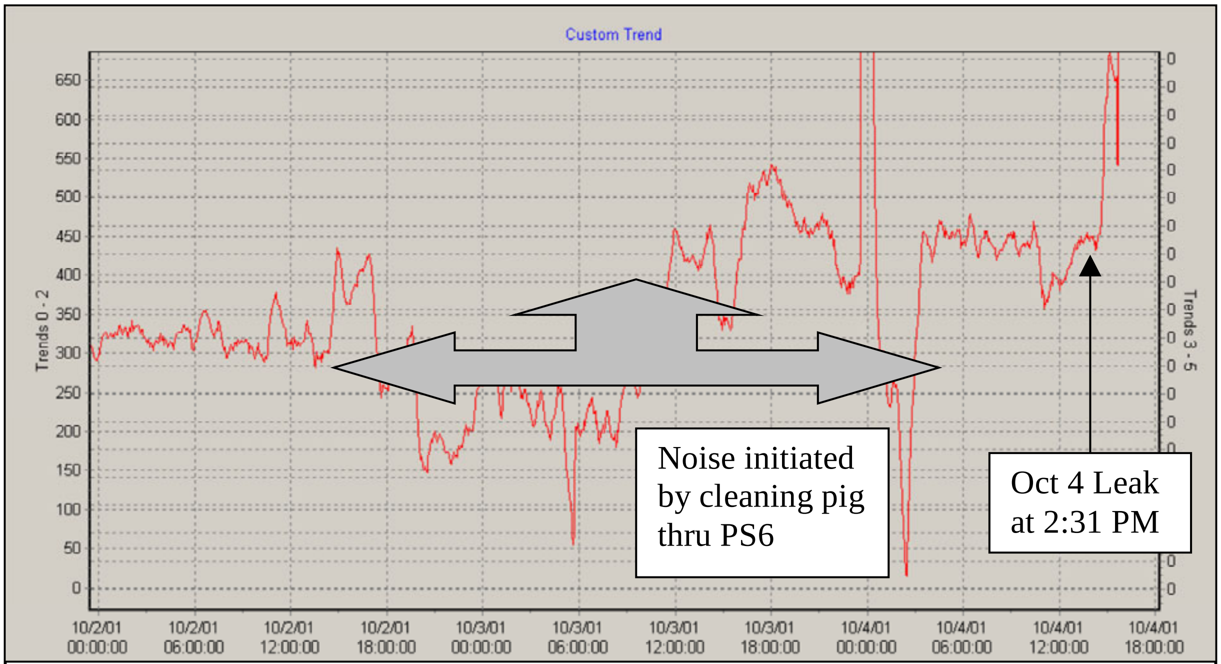


Figure III-1: Volume Balance between PS6 and PS7 uncorrected for long-term average.

### 3. Observations and Recommendations:

- The spill was visually detected shortly after the pipeline was shot, and before any leak detection systems alarmed.
- Although the on line leak detection systems were functioning as designed, there are limitations to these systems.
- There is ongoing work to improve the capabilities of existing leak detection systems.

#### A. Performance Summary:

(1) None of the APSC Leak Detection Systems alarmed, before the leak was discovered visually, as a result of the bullet hole leak of October 4, 2001. The current leak detection sensitivities are well within the 1% of throughput and is known BAT, per State regulatory requirements.

(2) The TVB Leak Detection System did detect a volume imbalance between Pump Station 6 and Pump Station 7; however, the imbalance did not meet other necessary validation conditions for an audible leak alarm to be sounded to the pipeline controllers at the Valdez Terminal. The TVB was operating normally, however flow measurement shifts after the passage of a cleaning pig through Pump Station 6 reduced the TVB's effective sensitivity.

(3) It is estimated the LVB Leak Detection System would have detected the leak within 4 to 10 hours after the onset of the leak.

**B. Improving Leak Detection:**

APSC has a Pipeline Leak Detection Improvement Project underway. The current leak detection sensitivities are well within the 1% of throughput and is known BAT, per State regulatory requirements. However, APSC is targeting improvements to its overall leak detection abilities to compensate for changing pipeline operations and routine operational activities. Steps are being taken to improve the current flow measurements and to improve the ability of the leak detection software to identify and to compensate for measurement shifts. Addressing these flow measurement shifts is one of the highest priorities of this effort. Improvements to the leak detection logic will allow for better processing of flow measurement shifts and slack line flow conditions. Flow measurement technology alternatives will also be evaluated and appropriate recommendations prepared for continual improvement in pipeline leak detection capabilities. Additionally, and as part of this project, the screen displays available to the Operations Control Center (OCC) Controllers will also be enhanced to provide more effective pipeline leak detection monitoring. Overall, the ability of the leak detection system to compensate for changing pipeline operations will be improved.

**Recommendation:** Continue on-going efforts to improve current systems.